

EK956009190US

T 9594 US

I hereby certify that this paper or fee is being deposited
with the U. S. Postal Service "Express Mail Post Office
- to Addressee" service under 37 CFR 1.10 on the date
indicated below and is addressed to the Commissioner
of Patents and Trademarks, Washington, D.C. 20231.

10-17-01 Date of Deposit
Signature of Person Mailing Paper or Fee
Name of Person Signing
10-17-01 Date of Signature

Drive Unit for a Fan in a Vehicle

5

The present invention relates to a drive unit for fans in vehicles, comprising a brushless direct current motor and an electronic actuation system.

Background of the Invention

10

15

A fan for vehicles with a drive unit that has a brushless direct current motor with an external rotor is already known from US 5,588,814. The drive unit of this fan is integrated into a collecting and distributing box, which surrounds the fan wheel. The external rotor, which is combined with the fan wheel to form a structural unit, is mounted on base parts of the collecting and distributing box. The air sucked in by the fan wheel is directed against the drive unit. A cooling air flow that is derived from the sucked-in air is fed to power semiconductors of the electronic actuation system, the power semiconductors being mounted on a circuit board situated below the drive unit.

20

Summary of the Invention

25

The drive unit according to the invention for a fan in a vehicle is an autonomous assembly that does not require any structural parts on the collecting and distributing box in order to mount the direct current electric motor or to

accommodate the electronic actuation system. According to the invention, the electronic actuation system is surrounded by a housing made of plastics that supports the electric motor. Since the drive unit forms an autonomous assembly, it can be combined with all kinds of housing parts and fan wheels to constitute a fan.

5 The housing surrounding the electronic actuation system is installed on the suction side of the fan so that the sucked-in air can be fed through inlet openings in the housing and can be used to cool the power semiconductors of the electronic actuation system as well as the components of the electric motor.

10 In a preferred embodiment of the drive unit, the housing has an integrally molded bearing sleeve for mounting the rotor of the electric motor, which has an external rotor. The bearing sleeve accommodates the bearings for mounting the journal of the external rotor. It also forms a guide channel for the cooling air flow that is needed for cooling the power semiconductors of the electronic actuation
15 system and that can enter through air inlet openings of the housing, parallel to the air flows between the rotor and the stator of the electric motor resulting from the pressure differential between the suction side and the pressure side of the fan.

According to another advantageous embodiment of the invention, the
20 electronic actuation system has a power part and a control part, which are mounted on separate circuit boards, the circuit board for the power part being made in that a conductor structure stamped out of sheet metal is encapsulated with plastic by means of injection-molding. Therefore, the power part can handle extremely high currents without endangering the sensitive components on the
25 printed circuit board of the control part.

Brief Description of the Drawings

Additional features and advantages of the invention ensue from the following
30 description of a preferred embodiment and from the appended drawings to which reference is made. The drawings show the following:

Figure 1 – a schematic side view of a drive unit for fans;

Figure 2 – a frontal view of the drive unit;

5 Figure 3 – a top view of the drive unit;

Figure 4 – an axial section of the drive unit; and

10 Figure 5 – a perspective illustrative view of a printed circuit board of the drive unit.

Description of the Preferred Embodiments

15 With reference to the drawings, a drive unit is shown that has a housing made of plastics as generally designated with the reference numeral 10. The generally parallelepipedal housing 10 consists of an upper part 12 and a lower part 14. The upper part 12 and the lower part 14 are connected to each other by means of latching connection elements 16a on the upper part 12 and 16b on the lower part 14. The upper part 12 has laterally projecting assembly tabs 18 on which the entire drive unit is suspended or attached in a fan housing. The upper part 12 of the housing 10 forms a supporting component.

20 The upper part 12 of the housing 10, as can be seen in Figure 4, has a generally cylindrical depression 20 at its top. From the bottom of this depression, an integrally molded bearing sleeve 22 projects perpendicularly upwards. Bearings 24, 26 for a bearing shaft 28 are mounted at the axial ends of the bearing sleeve 22. The bearing shaft 28 supports a generally pot-shaped rotor 30, configured as an external rotor, of an electric DC motor whose stator 32 is hollow-cylindrical in shape and is slipped onto the bearing sleeve 22. The axial position of the stator 32 is defined by the fact that its inner circumference bears on a shoulder 22a of the bearing sleeve 22. The electric motor is especially a brushless, four-phase DC motor.

From the windings of the stator 32, solid connection tags 34 on the periphery of the bearing sleeve 22 extend along the bottom of the depression 20 of the upper part 12 and through the openings surrounding the bearing sleeve 22 and into the inside of the housing 10. The housing 10 embeds a first circuit board 36 that extends over the entire width of the housing. This first circuit board 36 is a solid conductor structure encapsulated with plastic by means of injection-molding. The solid conductor structure consists of strip-like conductors 40 (Figure 5) that are stamped out of sheet metal. The circuit board 36 has a circular passage 42 that is arranged coaxially to the bearing sleeve 22. This passage 42 is surrounded by openings 44 the arrangement of which corresponds to the ends of the connection tags 34 of the stator 32 extending into the housing. Due to the four-polar configuration of the electric motor, there are eight such openings 44 with adjacent terminal ends of the conductors 40. The ends of the connection tags 34 are connected at the openings 44 with the corresponding conductor terminal ends by means of soldering.

On a narrow side of the circuit board 36, a few of the conductors 40 extend as contact tags 50a and 50b. The contact tags 50a and 50b project out of the housing 10 at a narrow end face and are surrounded by molded-on plug collars 52, 54. The dimensions of the contact tags 50a are smaller than those of the contact tags 50b and they serve to connect sensor and control lines, whereas the contact tags 50b serve to supply power.

Relatively large-volume filter components such as capacitors 56 and a choke 58 are arranged in the interior space of the housing 10, adjacent to the contact tags 50a and 50b. Four power semiconductors 60 are situated at the opposite end of the circuit board 36. The cooling fins of the power semiconductors 60 bear directly on an exposed metal surface of the conductors 40. The power semiconductors are electrically and thermally in contact with the conductors. The connection leads of the power semiconductors 60 are bent perpendicular with respect to the circuit board 36 and extend through corresponding openings of the

circuit board to reach a second, printed circuit board 62 that is situated parallel below the first circuit board 36. The control part of the electronic actuation system of the direct current motor is mounted on this printed circuit board 62, whereas the power part of the electronic actuation system is mounted on the first circuit board 36.

Air inlet openings 66 are arranged on the narrow side of the housing 10 opposite from the contact tags 50a, 50b, next to the power semiconductors 60. Furthermore, air outlet openings 68 are provided in the end face of the pot-shaped rotor 30 remote from the air inlet openings 66. The described drive unit is arranged in the housing of the fan in such a way that the air inlet openings 66 are situated on the suction side of the fan. The fan wheel of the fan is mounted and secured directly on the end of the bearing shaft 28 extending outward from the rotor 30. In operation, since the drive unit is located on the suction side of the fan, an air flow is fed through the air inlet openings 66 of the housing 10 into its inside and guided past the power semiconductors 60. The air then flows through the bearing sleeve 22, which also functions as a guide channel, to the end face of the rotor 30 and escapes through its openings 68. The cooling air flow cools the power electronics as well as the windings of the stator 32.

The described drive unit is quite compact and yet powerful, especially because of the good cooling of all of its thermally stressed components and because of its mechanically sturdy structure. An especially high rigidity of the assembly results from the fact that the circuit board 36 lies inside the housing 10 on the bottom of its upper part 12, thereby forming an axial buttress for the stator 32. Since no supporting components are needed, except for the upper part 12 of the housing 10, the mechanical construction is very simple and yet sturdy. During assembly, the various components of the drive unit are assembled essentially in the axial direction of the rotor 30 and then attached to each other, resulting in a simplified assembly that can be carried out automatically.